39C Savoonga Wind Generation Project
Final Closeout Summary Report
March 14, 2011

This Final Closeout Summary Report is filed with the federal grantor agency the Denali Commission ("Denali" or "DC") by the grantee partner Alaska Village Electric Cooperative, Inc. ("AVEC"). The federal grant awards affected by this report and by this project are: 0098-DC-2003-I12 and 349-07.

An initial project closeout report entitled "Award Transition and Closeout Summary" was submitted for this project on June 5, 2009. At the time, the project was still in construction under then-active Denali award 349-07. That initial transitional closeout report was submitted because funds allocated to this project from the earlier Denali award 0098-DC-2003-I12 had been fully expended, and the award had expired and was being closed. This final closeout report is now being filed because the project is complete, and award 349-07 has also expired and is also being closed. Federal funds in the amount of $40,512 are now available for de-obligation from Denali award 349-07. The following report represents the project status as of December 31, 2010.

Background - Savoonga is located on the northern coast of St. Lawrence Island in the Bering Sea, 164 miles west of Nome. It lies 39 miles southeast of Gambell, its neighboring St. Lawrence Island community. Savoonga has a second class city government, a population of 722, and lies at approximately 63.694170° North Latitude, -170.478890° (West) Longitude (Sec. 08, T021S, R061W, Kateel River Meridian.). Savoonga is located in the Cape Nome Recording District. Savoonga has a subarctic maritime climate with some continental influences during the winter. Summer temperatures average 40 to 51; winters average -7 to 11. Temperature extremes from -34 to 67 have been recorded. Average annual precipitation is 10 inches, including 58 inches of snowfall. The island is subject to prevailing winds averaging 18 mph. Freeze-up on the Bering Sea occurs in mid-November, with break-up in late May.

Activities - The main objective of this project is to generate electricity from a local renewable resource in an effort to reduce the local dependency on fuel oil as the sole source for electric power generation. All work described hereunder was accomplished by this project, except as noted. Project scope included planning, design, construction and commissioning of 2 new 100 kW capacity wind turbines, a fiber optic communications link, and a secondary load system, at a site adjacent to the community's abandoned landfill to the west of the village. The wind generators' output will augment the prime source generation provided by the new diesel-powered modular power plant recently installed under Denali project 39B.

The conical steel towers supporting the wind turbine generators are 32 meters tall; they are attached to steel beam foundations, driven steel piles, and anchors connecting piles to the bedrock. This foundation system was designed to counteract the overturning moment forces from wind and vibration. In order to preserve the integrity of the permafrost surrounding the foundations, thermosiphons were installed adjacent to all foundation piles. The new wind turbines were connected to the new diesel power plant (completed in 2008 under Denali project 39B) via a new, three-phase primary distribution line built under separate Denali project 39F during the same time as the wind turbine project. The fiber optic communications link provides communication between the wind turbines and the control module installed in the new power plant, and this combined system allows the wind turbines to be either manually or

automatically operated both at the power plant and from AVEC headquarters in Anchorage, maximizing operational stability and allowing remote trouble shooting in the event of alarms or warnings. The control module at the new power plant also houses electronic diesel engine controls and fully automated switchgear that achieve a seamless integration of the energy produced by the wind turbines, which is intermittent in nature, into the reliable, on-demand stream of energy provided by the power plant's diesel generators.

In addition to these components, the system is fitted with a secondary load system comprised of a 140 kW electric water heater and related controls and switching relays that serve as a "dump load" for the wind turbines. This system will absorb excess electrical energy during those periods when wind turbine output exceeds the community load, transferring the excess energy as heat to the AVEC power plant in the near term, and potentially to other building(s) that may be added to the heat transfer circuit from the AVEC power plant in the future. Taken together, these control systems – wind turbine controls, diesel engine controls, and secondary load system - leverage the renewable resource to the fullest possible extent.

Construction was managed by STG, Inc., which also provided much of the heavy construction equipment and skilled labor employed on the job. Local skilled and unskilled labor was also employed. Northern Power Systems manufactured the turbines and supplied the towers, and provided some installation and commissioning assistance. Engineering of the foundations and secondary load system was accomplished by Coffman Engineers, and additional system engineering was provided by AVEC staff.

Funding, Costs and Cost Containment - Funding was provided by Denali Commission grants to AVEC, and matching cash contributions from AVEC. Funding and costs are as follows:

	Federal portion of award	AVEC match portion	Total All Sources
DC award 0098-DC-2003-I12	$ 562,897	$ 10,137	$ 573,034
DC award 349-07	$ 2,048,332	$ 280,000	$ 2,328,332
Total Funding (Budget)	**$ 2,611,229**	**$ 290,137**	**$ 2,901,366**
DC award 0098-DC-2003-I12	$ 562,897	$ 10,137	$ 573,034
DC award 349-07	$ 2,007,820	$ 274,462	$ 2,282,282
Total Actual Costs	**$ 2,570,717**	**$ 284,599**	**$ 2,855,316**
Funding in excess of costs	$ 40,512	$ 5,538	$ 46,050

Total funding ($2,901,366) exceeds total actual costs ($2,855,316) by $46,050. Of this amount, federal funds in the amount of $40,512 are now available for de-obligation from DC award 349-07 on this project.

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Design Generating Capacity (kW)	200
Constructed Generating Capacity (kW)	200

The completed, installed generating capacity is equal to the design capacity.

Initial budgeted project cost	$14,507 per kW
Final project constructed cost	$14,277 per kW
Denali Commission benchmark range	N/A

Currently, no cost containment benchmarks have been established by the Denali Commission for projects of this type.

Problems Encountered/Lessons Learned - Challenging soil conditions (saturated, compressible soils underlain by permafrost) at the project location created substantial engineering challenges to develop an adequate foundation design. Geotechnical information collected by excavation near the turbine sites initially indicated that bedrock was near the surface and that a mass concrete foundation would be the best alternative. However, before construction began on the wind turbines, the contractor building a new school at a site about 1500 feet away reported that the presumed bedrock that they were encountering (at the school site) was actually a collection of very large boulders interspersed with saturated soil. Drilling equipment that was in use at the school construction site was then used to explore further at each wind turbine site, whereupon it was confirmed that the wind farm area was also populated with large boulders, not bedrock. The planned concrete foundation concept was then judged to be inappropriate for this site; a new design was initiated that specified a driven steel pile foundation for each tower.

The cement and rebar that was shipped to Savoonga to accomplish the original foundation design is surplus to the project, and it is proposed that it be stored in the community, to be used for walkways around the DC-funded power plant and tank farm, and/or made available to local residents and community organizations.

The original concept was to build an amalgamated project, combining three projects: tank farm (Denali project 39A), power plant (project 39B) and this wind farm (project 39C). This concept had to be abandoned due to non-concurrent funding availability and considerations of wind turbine type, foundation design, and wind farm location. The long actual project schedule required separate mobilizations of equipment and materials, and separate contractors, for the three projects. As with other AVEC capital projects in rural Alaska, challenging work conditions and remote locations add to the cost of completing the project. This site, on St. Lawrence Island which at its nearest point lies only 38 miles from the Russian mainland, is one of the more distant sites to mobilize to and support.

Conclusions - The project partners overcame substantial technical challenges in the design phase and considerable environmental challenges in the construction phase. Despite these obstacles, the wind turbine installation was completed with a high level of quality and craftsmanship, and within budget. The project as constructed meets all current regulations and codes. It meets Denali Commission goals to include alternative energy in the scope of AVEC projects where practical.